

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, DC 20554**

|                            |   |                        |
|----------------------------|---|------------------------|
| In the Matter of           | ) |                        |
|                            | ) | IB Docket No. 11-109   |
| Comment Sought on Ligado's | ) |                        |
| Modification Applications  | ) | SAT-AMD-20180531-00044 |
|                            | ) | SAT-AMD-20180531-00045 |
| To: The Commission         | ) |                        |

**REPLY COMMENTS OF LIGADO NETWORKS LLC**

Gerard J. Waldron  
Brian Smith  
Ani Gevorkian  
COVINGTON & BURLING LLP  
One CityCenter  
850 Tenth Street, NW  
Washington, DC 20001  
(202) 662-6000

*Counsel for Ligado Networks LLC*

July 19, 2018

**TABLE OF CONTENTS**

|             |  |           |
|-------------|--|-----------|
| <b>I.</b>   | <b>INTRODUCTION AND SUMMARY .....</b>  | <b>1</b>  |
| <b>II.</b>  | <b>THE PARAMETERS SET FORTH IN THE AMENDMENT ADOPT THE POSITION OF THE FAA AND DOT AND ENSURE THAT LIGADO’S TERRESTRIAL NETWORK WILL BE COMPATIBLE WITH AVIATION SAFETY.....</b> | <b>4</b>  |
| <b>III.</b> | <b>ALL OTHER GPS DEVICES ALSO RECEIVE PROTECTION FROM LIGADO’S AMENDMENT.....</b>  | <b>12</b> |
| <b>IV.</b>  | <b>IRIDIUM’S COMPLAINTS ARE BASELESS AND SHOULD BE REJECTED SINCE DOD CIO CONCLUDED THAT LIGADO’S OPERATIONS WILL NOT CAUSE HARMFUL INTERFERENCE. ....</b>                       | <b>20</b> |
| <b>V.</b>   | <b>RECENT FILINGS BY SATCOM AND WEATHER PARTIES SIMPLY REHASH ARGUMENTS LIGADO HAS ALREADY ADDRESSED. ....</b>   | <b>21</b> |
| <b>VI.</b>  | <b>THE COMMISSION SHOULD SEIZE THE OPPORTUNITY TO UNLOCK PRIME LOW FREQUENCY MID-BAND SPECTRUM FOR THE TRANSITION TO 5G.....</b>   | <b>23</b> |

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, DC 20554**

|                            |   |                        |
|----------------------------|---|------------------------|
| In the Matter of           | ) |                        |
|                            | ) | IB Docket No. 11-109   |
| Comment Sought on Ligado’s | ) |                        |
| Modification Applications  | ) | SAT-AMD-20180531-00044 |
|                            | ) | SAT-AMD-20180531-00045 |
| To: The Commission         | ) |                        |

**REPLY COMMENTS OF LIGADO NETWORKS LLC**

**I. INTRODUCTION AND SUMMARY**

The Commission now has a record sufficient to conclude that under the parameters of Ligado’s license modification applications (“Modification Applications”) as amended by its May 31, 2018 Amendment (“Amendment”), certified aviation GPS devices will be protected; all other GPS devices will be protected; and no other stakeholders will experience harmful interference as a result of Ligado’s terrestrial deployment. The Federal Aviation Administration (“FAA”) and the Department of Transportation (“DOT”) conducted the analysis that yielded the new operating parameters contained in the Amendment. The comments filed in response to the Public Notice on the Amendment did not raise any new issues or new considerations regarding issues already covered extensively in the docket. Ligado has worked with other stakeholders to ensure the record is complete, and the Commission now has the information it needs to move forward on the Modification Applications as amended. These Reply Comments review some of the material already in the record responsive to the recently-filed comments. Ligado therefore urges the

Commission to approve the Modification Applications as amended and thereby unlock the significant benefits to America's citizens, industries, and spectrum leadership that await as a result.

With regard to certified aviation GPS devices, the FAA and DOT conducted extensive analysis over a two-year period and concluded that the parameters set forth in the DOT's April 2018 Global Positioning System (GPS) Adjacent Band Compatibility Assessment ("DOT Report") would protect certified GPS devices. The Amendment simply incorporates those parameters into the Modification Applications to ensure that Ligado's network will be compatible with aviation safety. Some commenters raised questions about the DOT analysis and the proposed 250-foot standoff cylinder used in that analysis, specific details regarding antennas, and the required reporting obligations—but none of these considerations should preclude Commission action. Metro Aviation ("Metro"), a prominent helicopter operations company, stated in its comments that Ligado's proposal will *not* affect the safe operation of helicopters for a multitude of reasons, primarily related to the obligations existing FAA regulations already impose on helicopters and the practical realities of safe helicopter operations. To the commenters that raised concerns about the reporting obligations that Ligado set forth in the Amendment, Ligado repeats its commitment to appropriate reporting procedures, and its willingness to work with stakeholders to develop further the reporting procedures that Ligado has proposed.

Comments filed on the Amendment also make clear that the new operational parameters will protect all other GPS devices. Garmin International, Inc. ("Garmin") stated in its comments that Garmin tested its devices with Ligado's proposed operations against the 1 dB decrease in the Carrier-to-Noise-Density ratio ("C/N<sub>0</sub>") standard. This important information from Garmin is

buttressed by thousands of hours of empirical testing demonstrating that Ligado's operations at the proposed levels will not harm the operations of any other class of GPS device.

Furthermore, individually and collectively, the GPS co-existence agreements Ligado has entered into with the leading GPS manufacturers indicate that the reduced operational power and out-of-band emissions levels proposed by Ligado, and specifically requested by the GPS companies to be submitted as license modifications, meet the needs of GPS devices. More fundamentally, the Air Force and the National Telecommunications and Information Administration ("NTIA") long ago recognized and agreed that GPS receivers are only entitled to protection extending from 1563-1587 MHz.

Although some commenters continue their repeated attempts to divert the Commission's attention to addressing the role of the 1 dB  $C/N_0$  degradation standard in this proceeding, this question need not be resolved prior to the Commission's approval of the License Modifications. Not only is the 1 dB standard inaccurately and inconsistently measured, arbitrary, and a flawed proxy for harmful interference as Ligado has previously explained, but it also is, more importantly, simply inappropriate for purposes of this proceeding because the Commission has never used a 1 dB  $C/N_0$  degradation standard to protect a service in a band where that service is not licensed to operate. Moreover, as Trimble pointed out more than two years ago, the Commission has a sufficient basis to move forward without deciding this question.<sup>1</sup>

---

<sup>1</sup> See Letter from Russell H. Fox, Counsel for Trimble Navigation Limited to Marlene H. Dortch, FCC Secretary, IB Docket No. 12-340; IBFS File Nos. SAT-MOD-20120928-00160; SAT-MOD-20120928-00161; SAT-MOD 20101118-00239; SES-MOD-20121001-00872; IB Docket No. 11-109; DA 16-442 (June 8, 2016), at 2 (indicating that "... [Ligado's] applications could be granted without addressing more generally the criteria by which GPS receivers should be protected from other terrestrial operations").

Finally, Iridium Communications Inc.’s (“Iridium”) assertion that Ligado’s proposed terrestrial operations will produce harmful interference to Iridium’s satellite devices is simply incorrect. In fact, analysis produced by a third-party consultant to the Department of Defense (“DOD”), Iridium’s largest customer, confirms that, contrary to the company’s claims, Iridium’s devices will not experience harmful interference from Ligado’s operations in the 1627.5-1637.5 MHz band.

**II. THE PARAMETERS SET FORTH IN THE AMENDMENT ADOPT THE POSITION OF THE FAA AND DOT AND ENSURE THAT LIGADO’S TERRESTRIAL NETWORK WILL BE COMPATIBLE WITH AVIATION SAFETY.**

The operating parameters Ligado proposes in its Amendment came directly out of the DOT Report and reflect the extensive analysis that the FAA and DOT undertook with regard to the protection of certified aviation devices. The key provision of the DOT Report, upon which Ligado’s Amendment rests, is the following:

The FAA analysis of certified aviation indicate that protection of certified avionics, operating under the assumption of the described 250 foot (76.2 m) radius assessment zone, requires that the ground station transmission not exceed 9.8 dBW (10W) (cross-polarized) at 1531 MHz.<sup>2</sup>

Based on this conclusion, Ligado requested in its Amendment that the Commission (1) require that Ligado’s ATC base stations operating in 1526-1536 MHz (the “Lower Downlink Band”) not exceed an EIRP of 9.8 dBW (10 W) with a +/- 45 degree cross-polarized base station antenna, and (2) prohibit any Ligado ATC base station antenna in the Lower Downlink Band from

---

<sup>2</sup> U.S. Department of Transportation, *Global Positioning System (GPS) Adjacent Band Compatibility Assessment Final Report*, at 158 (April 2018), <https://www.transportation.gov/sites/dot.gov/files/docs/subdoc/186/dot-gps-adjacent-band-final-reportapril2018.pdf> (“DOT Report”).

operating at a location less than 250 feet laterally or less than 30 feet below an obstacle clearance surface established by the FAA (under 14 C.F.R. Part 77 and implementing orders and decisions).<sup>3</sup> As a result, Ligado’s Amendment adopts the analysis of the expert government agency, the FAA, and the recommendation of the DOT.

Nonetheless, some commenters seem to second-guess the FAA’s expertise and its analysis.<sup>4</sup> These commenters have raised questions about the proposed 250-foot standoff cylinder, its effect on unmanned aircraft systems (“UAS”), specific details regarding antennas, and the required reporting obligations. Ligado urges the Commission to defer to the judgment of the expert agencies, since none of these concerns suggest that certified aviation receivers would experience harmful interference as a result of Ligado’s proposed terrestrial operations.

**1. Helicopters.** Ligado’s proposed 250-foot standoff cylinder was used by the FAA in its analysis, and the same standoff cylinder was incorporated into the DOT Report. Garmin and Aviation Spectrum Resource Inc. (“ASRI”), however, speculate about the effect of the 250-foot standoff cylinder on helicopter operators that use GPS.<sup>5</sup> Yet as Metro, a leading outfitter of

---

<sup>3</sup> Amendment to License Modification Applications, IBFS File Nos. SES-MOD-2015-1231-00981, SAT-MOD-20151231-00090, and SAT-MOD-20151231-00091 (“Amendment”).

<sup>4</sup> It is worth underscoring that the 9.8 dBW (10W) cross-polarized limit Ligado is requesting is based off of the most limiting use case for helicopters. Because the most limiting use case for fixed-wing aircraft in the DOT Report resulted in a much higher power level of 28.89 dBW using the Monte Carlo methodology or 29.06 dBW using the Analytical Statistical methodology, any concerns regarding fixed-wing operations are baseless. *See* DOT Report at 137, Table 5-2.

<sup>5</sup> *See* Comments of Garmin International, Inc., IB Docket No. 12-340; SAT-MOD-20120928-00160; SAT-MOD-20120928-00161; SES-MOD-20121001-00872; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045; IB Docket No. 11-109 (July 9, 2018), at 6-8 (“Garmin Comments”); Comments of Aviation Spectrum Resource Inc., IB Docket No. 11-109; 12-340; IBFS File Nos. SES-MOD-20151231-00981; SAT-MOD-20151231-00090; SAT-MOD-20151231-00091; SES-AMD-20180531-00856 (July 9, 2018) (“ASRI Comments”), at 3-5.

helicopters and provider of air-ambulance services, has explained both in response to the Public Notice and elsewhere in the record,<sup>6</sup> Ligado’s proposal will *not* affect the safe operation of helicopters for a multitude of reasons.

*First*, both in practice and pursuant to regulatory requirements, pilots should not rely on GPS devices near obstacles. FAA regulations generally provide that an “aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure,” and they provide an exception for helicopter operations, only if “the operation is conducted without hazard to persons or property on the surface.”<sup>7</sup> As Metro explained in its comments, “it would be extremely hazardous to operate closer than 500 feet from an object (including a Ligado antenna tower) while relying on a certified aviation GPS device to provide navigation guidance to avoid that object.”<sup>8</sup> Instead, safe operations in such a situation require flight by visual reference.<sup>9</sup> The FAA took these considerations into account when evaluating the 250-foot standoff cylinder and in determining that a 250-foot cylinder provided sufficient protection. Thus, potential degradation of the GPS signal within 250 feet of a tower does not present safety of flight issues.

*Second*, with regard to the most essential helicopter uses—including the medical missions ASRI references in its comments<sup>10</sup>—FAA regulations require that pilots give ample vertical

---

<sup>6</sup> See Comments of Metro Aviation, IB Docket No. 11-109; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045 (July 6, 2018) (“Metro Comments”); Letter from Mike Stanbury, President, Metro Aviation, to Ajit Pai, Chairman, Federal Communications Commission, IB Docket No. 11-109 (July 25, 2017).

<sup>7</sup> 14 C.F.R. § 91.119.

<sup>8</sup> Metro Comments at 2.

<sup>9</sup> *Id.*

<sup>10</sup> See ASRI Comments at 4.

clearance to terrain and obstacles. Specifically, regulations applicable to Helicopter Air Ambulance (“HAA”) operations require the pilot-in-command of an HAA operation to ensure that all terrain and obstacles along the planned route of flight are cleared vertically by *300 feet* during day operations and 500 feet during night operations.<sup>11</sup> This regulation, applicable to all of the approximately 1,100 HAA aircraft currently operating in the United States, further reinforces why the DOT and FAA signed off on the 250-foot standoff cylinder, and why potential degradation of the GPS signal within 250 feet of a tower does not present safety of flight issues. Garmin’s references to the performance of helicopter terrain awareness and warning systems (“HTAWS”) in proximity to Ligado’s transmitters by ASRI are incorrect, since the aircraft would already be operating below the alerting altitude when inside the 250-foot cylinder. Importantly, the purpose of the HTAWS system is to provide terrain awareness and warnings—not to provide navigation or guidance to fly in close proximity to obstructions.<sup>12</sup> As the RTCA succinctly explains, “HTAWS is not intended to be used as an aid for navigation.”<sup>13</sup>

*Third*, Ligado’s proposal provides overflight protection. The stand-off cylinder will extend 30 feet above the *antenna*, rather than the tower (thereby increasing the protected area for an overflying helicopter whenever the antenna is not deployed at the top of the tower, which will most often be the case), so even if the antenna is located at the top of a tower, “a helicopter operating safely should be further than 30 feet above such an obstruction.”<sup>14</sup>

---

<sup>11</sup> See 14 C.F.R. § 135.615 (b) (1)-(2).

<sup>12</sup> See RTCA DO-309 §1.4 Intended Function.

<sup>13</sup> *Id.*

<sup>14</sup> See Metro Comments at 2-3.

Furthermore, the power limit developed by the FAA and DOT regarding the 250-foot cylinder represents the worst-case scenario of a number of interrelated considerations, including antenna height, downtilt, beam reflection, and helicopter bank angle—a rare power event that is unlikely to occur in the real world (a  $10^{-6}$  probability of occurrence). On top of that rare scenario, the FAA analysis added a safety margin of 2-6 dB. For this reason, it is not a reasonable assumption that GPS will be entirely unavailable inside the cylinder. In fact, analysis that was shared with the FAA and the RTCA shows that in the real world, a GPS receiver would receive no interference from a Ligado antenna in significant portions of the airspace within the cylinder. Thus, interference at the level that could degrade a GPS signal is likely to be temporary as the helicopter moves through the cylinder.

**2. Unmanned Aircraft Systems.** Some commenters suggest that UASs operating within the 250-foot cylinder may experience a loss of navigational accuracy/reliability.<sup>15</sup> Although no party has presented illustrative examples or any data to support this point, Ligado has worked closely with various stakeholders involved with UAS over the past two years and has used that experience to assess a common example and explain why this concern is misplaced. UASs are often used for the close visual inspection of utility towers and as explained below, for that sort of typical UAS use case, Ligado's proposed operations would not present a concern.

If a UAS were inspecting a utility tower at close range, that tower would be emitting energy significantly greater than Ligado's proposed 9.8 dBW (10W). As a result, any potential impairment to the UAS would come from a signal that would dwarf Ligado's. This reality of exponentially higher power signals that UASs will need to face if they are to operate in the types

---

<sup>15</sup> See ASRI Comments at 4; Comments of The Boeing Company, SAT-AMD-20180531-00044 SAT-AMD-20180531-00045; IB Docket No. 11-109; IB Docket No. 12-340 (July 9, 2018), at 3.

of environments suggested by the commenters is no doubt being taken into account by the sophisticated companies in the aviation sector that are developing UASs and that rely on modern, state-of-the-art technology. UASs, like cellular and tablet devices, utilize a proximate on-board transmitter, which requires the GPS to be resilient to overload interference. Furthermore, UASs designed for inspection missions are typically equipped with supplemental navigation systems that permit them to operate normally in GPS denied environments (*e.g.*, close proximity to energized power transmission lines). A UAS moving *inside* the standoff cylinder would therefore only experience any interference from Ligado temporarily if at all.

**3. Antenna specifications.** Some commenters also raised the possibility of Ligado making much more granular commitments regarding its deployment plan. Garmin, for instance, suggested that Ligado should make antenna height and antenna downtilt commitments and provide additional specificity with regard to polarization.<sup>16</sup> Setting aside the fact that, as a practical matter, it would be nearly impossible for Ligado to specify antenna heights before knowing the location of its antennas, these requests are not well thought out since, regardless of antenna specifications, any real-world deployment of Ligado's operations would result in more favorable conditions than those assumed by FAA and DOT modeling.

As explained in Ligado's initial Comments, the model-based EIRP limit contained in the Amendment already accounts for extreme worst-case interference scenarios that would never conceivably occur simultaneously. In fact, the worst-of-the-worst assumptions that led to the EIRP limit Ligado is requesting in its Amendment were so unrealistic, they could not even be

---

<sup>16</sup> See Garmin Comments at 5.

recreated inside of test chambers.<sup>17</sup> Consequently, as illustrated in Table 1 below, any application of the FAA/DOT assessment model using the actual tower height and downtilt in a network would result in a *higher* permissible power level for Ligado’s operations than is indicated by the models developed by the FAA.

**Table 1**<sup>18</sup>

| <b>Tower Height (m)</b> | <b>Antenna Downtilt (deg)</b> | <b>Antenna Polarization</b> | <b>AC Antenna Height (m)</b> | <b>EIRP Limit (dBW)</b> |
|-------------------------|-------------------------------|-----------------------------|------------------------------|-------------------------|
| 10                      | 8                             | Cross-Polarized             | 10                           | 15.6                    |
| 10                      | 6                             | Cross-Polarized             | 10                           | 14.4                    |
| 10                      | 4                             | Cross-Polarized             | 14                           | 13.8                    |
| 10                      | 2                             | Cross-Polarized             | 14                           | 12.5                    |
| 20                      | 8                             | Cross-Polarized             | 8                            | <b>9.8</b>              |
| 20                      | 6                             | Cross-Polarized             | 8                            | 10.2                    |
| 20                      | 4                             | Cross-Polarized             | 13                           | 10.4                    |
| 20                      | 2                             | Cross-Polarized             | 16                           | 10.4                    |

**4. Reporting obligations.** Finally, some commenters raised questions about the proposed reporting obligations Ligado set forth in the Amendment.<sup>19</sup> Ligado hereby repeats its commitment to appropriate (*i.e.*, useful for protecting aviation safety) reporting requirements and its willingness to work with other stakeholders to further develop the reporting procedures Ligado has proposed. As discussed in prior submissions, the reporting requirements proposed by

---

<sup>17</sup> See Comments of Ligado Networks LLC, IB Docket No. 11-109; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045 (July 9, 2018), at 3.

<sup>18</sup> See DOT Report at 148-150, Figures 5-10 and 5-12.

<sup>19</sup> ASRI Comments at 4-7; Garmin Comments at 7.

Ligado are *not* a replacement for existing Commission<sup>20</sup> and FAA<sup>21</sup> reporting obligations;

Ligado will adhere to all relevant tower reporting rules that apply to wireless carriers.

Furthermore, Ligado has been committed to working with other stakeholders to develop

additional reporting procedures to ensure the dissemination of information relevant to protecting

aviation safety.<sup>22</sup> Ligado remains willing to put this commercially sensitive information in a

database that can be accessed by all stakeholders and to pay for the building and maintenance of

this database by any responsible party.<sup>23</sup>

---

<sup>20</sup> Commission rules require applicants to provide both local notice and national notice of the proposed construction. 47 C.F.R. § 17.4(c)(3)-(4). If approved, the Commission assigns the antenna an Antenna Structure Registration number, which must be publicly displayed near the base of the antenna. 47 C.F.R. § 17.4 § 17.4(f)-(g). Once construction is complete the wireless carrier must again notify the FAA and Commission (via FAA Form 7460-2 and FCC Form 854, respectively). The wireless carrier has a continuing obligation to ensure the antenna complies with all relevant FAA chapters specified on its registration. 47 C.F.R. § 17.4 § 17.6(a). Any failure to comply will subject the carrier to a Commission enforcement action. Any changes to the tower thereafter require the wireless carrier to obtain prior approval by both the FAA and the Commission by completing this process in its entirety.

<sup>21</sup> FAA requires wireless carriers to file a Notice of Proposed Construction or Alteration (FAA Form 7460-1) for proposed construction or modification of a tower that either would be more than 200 feet above ground or within protected airspace surrounding a public airport. 47 C.F.R. § 17.7; 14 C.F.R. § 77.9. The FAA then conducts a study to determine whether the tower would pose a hazard to air navigation. 14 C.F.R. § 77.29. If that study determines the tower poses no hazard, the wireless carrier applicant must additionally submit an application for Antenna Structure Registration to the Commission (FCC Form 854). *See* 47 C.F.R. § 17.4(c)(2).

<sup>22</sup> On this point, it is somewhat baffling that ASRI commented on the need for a database when more than a year ago, Ligado specifically asked ASRI to help create and manage this very database, and offered to finance the building and maintenance of this database. ASRI declined then yet now complains that there is no mechanism for a database.

<sup>23</sup> Ligado finds equally curious the question ASRI poses on pages 6 to 7 of its comments. ASRI asks: “Because airborne GPS receivers cannot differentiate types or frequency of interference for the pilot, would operators now be correct to assume all low-level interference to GPS is from Ligado in the absence of ready information on Ligado's base stations?” Based on the FAA and DOT analysis the answer is that the interference will not be from Ligado. But the premise of this question indicates that GPS devices experience other interference, so Ligado expects the GPS companies will want to know what measures ASRI is taking with regard to that interference, and

\* \* \*

The bottom line, as other commenters in this proceeding have recognized,<sup>24</sup> is that under the operating parameters proposed in Ligado’s Amendment, certified aviation receivers unquestionably can safely coexist with Ligado’s proposed operations.

### **III. ALL OTHER GPS DEVICES ALSO RECEIVE PROTECTION FROM LIGADO’S AMENDMENT.**

As a variety of comments make clear, the provisions of Ligado’s Amendment will protect all other GPS devices as well as certified GPS aviation devices.<sup>25</sup> In its comments, Garmin states for the first time that it tested Ligado’s proposed operations using the 1 dB standard and on that basis does not oppose the Modification Applications.<sup>26</sup> In addition to this testing, thousands

---

whether the parties responsible for such interference are taking as many remediating measures and making as many compromises as Ligado has made.

<sup>24</sup> See, e.g., Comments of Mark A. Sturza, SES-MOD-20151231-00981; SAT-MOD-20151231-00090; SAT-MOD-20151231-00091; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045; IB Docket No. 11-109 (July 6, 2018).

<sup>25</sup> See Garmin Comments at ii; Comments of Deere & Company, IBFS File Nos. SES-MOD-20151231-00981; SAT-MOD-20151231-00090; SAT-MOD-20151231-00091; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045; IB Docket No. 11-109 (July 9, 2018), at 7 (“Deere Comments”); Comments of Trimble Inc., IB Docket No. 12-340; IBFS File Nos. SAT-MOD-20151231-00090; SAT-MOD-20151231-00091; SES-MOD-20151231-00981; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045; IB Docket No. 11-109 (July 9, 2018), at 2 (“Trimble Comments”); Comments of Roberson and Associates, IB Docket No. 11-109; IBFS File Nos. SAT-AMD-20180531-00044 and SAT-AMD-20180531-00045 (July 9, 2018); Comments of Stephen A. Wilkus, IB Docket No. 11-109; IBFS File Nos. SAT-MOD-20151231-00090, SAT-MOD-20151231-00091; SES-MOD-20151231-00981; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045 (July 9, 2018), at 2-3 (“Wilkus Comments”).

<sup>26</sup> Garmin Comments at 10. A recently-filed *ex parte* letter by certain satellite communications and weather-related entities includes a quotation from Garmin indicating that “the 1 dB standard is the appropriate determinant of harmful interference to GPS and other Radionavigation Satellite Service (‘RNSS’) receivers.” See Letter from Joel N. Myers *et al.* to Ajit Pai, Chairman, Federal Communications Commission, IB Dockets No. 11-109, 12-340; RM-11681; IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, SES-AMD-20180531-00856, SAT-AMD-20180531-00044, SAT-AMD-20180531-00045 (July 18,

of hours of empirical testing at the labs of the Department of Commerce (“DOC”) and DOD generated substantial data that show the proposed levels will not affect the operations of all other classes of GPS devices or that they can be readily remedied.<sup>27</sup> In fact, these devices will receive even greater protection than required by the GPS industry due to the reduced power level reflected in the Amendment—a power level that represents a cumulative power reduction in the Lower Downlink Band of more than 99.9% from the level authorized in 2010 and more than 99.3% from the maximum reflected in the Modification Applications.<sup>28</sup>

The co-existence agreements Ligado reached with the five major GPS manufacturers—including three that filed in response to the Public Notice—indicate that the reduced operational power and out-of-band emissions levels proposed by Ligado, *which were specifically requested by the GPS companies to be submitted as license modifications*, meet the needs of GPS devices.<sup>29</sup> Three of the GPS device commenters stress that each of their respective co-existence

---

2018), at 3 (“SATCOM and Weather Parties’ Letter”). That letter omits this most recent acknowledgement from Garmin that Ligado satisfies the 1 dB standard for Garmin devices.

<sup>27</sup> See Comments of Garmin at 10; see also Roberson and Associates, LLC, *Results of GPS and Adjacent Band Co-Existence Study*, IB Docket No. 11-109 (May 11, 2016) (“RAA Report”); Dr. William Young *et al.*, *NASCTN, LTE Impacts on GPS: Test and Metrology Plan* (July 22, 2016), available at <https://www.nist.gov/sites/default/files/revise-test-plan-impact-of-lte-on-gps-22-july-2016.pdf>, (“NASCTN Report”); see also Letter from Gerard J. Waldron, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109; IBFS File Nos. SES-MOD-20151231-00981; SAT-MOD-20151231-00090; SAT-MOD-20151231-00091 (June 5, 2017), at App’x A, pp. 17-21 (“Ligado June 2017 White Paper”) (analyzing results of RAA Report, NASCTN Report).

<sup>28</sup> The comments of Stephen Wilkus underscore the magnitude of the reduction Ligado is willing to make. As Mr. Wilkus explains, “That Ligado concedes to accept this low limit is remarkable given that they had earlier applied for a 42 dBW authorized level, a decrease of 32.2 dB or a linearized factor of 1660 times lower power, just 0.060% of the power authorized in 2010. This 9.8 dBW level, for Ligado macrocells, is the power used in many small cells today.” Wilkus Comments at 2.

<sup>29</sup> See Ligado June 2017 White Paper at 7-8; see also Comments of Garmin at 10.

agreements addresses only their own devices.<sup>30</sup> Of course that is the case, and no one has ever suggested otherwise. But a factfinder can look at the statements from each individual manufacturer—including TopCon and NovAtel, two other GPS high-precision device manufacturers with which Ligado has co-existence agreements—and find that all of the manufacturers with which Ligado has coexistence agreements taken together represent the vast majority of all GPS devices in the market, as documented in the 2016 Brattle Group Report included in Ligado’s previous filings.<sup>31</sup> Furthermore, it has long been established that cellular devices, which currently represent 79% of the GPS device market, raise no issues with regard to Ligado’s proposed terrestrial deployment—and the market share of cellular devices is expected to continue growing each year. Any other potential concerns are diminishing each day as a result of well-documented market forces like retirements, replacements, upgrades, and the substitution of smartphones and tablets for free-standing GPS devices.<sup>32</sup>

Commenters also continue to assert the importance of the 1 dB decrease in  $C/N_0$  standard to this proceeding. There are two separate and distinct problems with their position on this issue. *First*, commenters urge that the 1 dB metric is the only metric that can or should be used to measure harmful interference even for transmissions in an adjacent band. But there is no Commission precedent or other support for this proposition, and the commenters do not cite to

---

<sup>30</sup> See Garmin Comments at ii; Deere Comments at 7; Trimble Comments at 2.

<sup>31</sup> See Coleman Bazelon, *Putting Spectrum to Work: Sharing Between Ligado Networks and Its GPS Neighbors*, The Brattle Group (May 23, 2016) (“Brattle Report”) cited in Comments of Ligado Networks, IB Docket NO. 11-109 (May 23, 2016).

<sup>32</sup> *Id.* at A1-A4. The number of potentially impacted devices in 2018 is therefore smaller than the number of such devices in 2016, and the number of potentially impacted devices in 2020 will be smaller still than the number of such devices in 2018.

any.<sup>33</sup> The Commission can thus approve the Modification Applications as amended *without* having to resolve for all time and for all scenarios the merits of the 1 dB C/N<sub>0</sub> metric.<sup>34</sup>

It is critical to bear in mind that the question of GPS device protection at issue in this proceeding relates *not* to the operation of GPS devices in their own allocated band, but rather to the operation of some GPS devices for their own purposes *in the spectrum assigned to Ligado—i.e., a band that is not allocated to GPS.*<sup>35</sup> A review of the history and origin of the 1 dB metric reveals that it is inappropriate as applied to Ligado’s potential effects on GPS because of its exclusive designation as a metric applicable to *co-channel* emissions only. Here, that would mean emissions into the GNSS band at 1559-1610 MHz. There is no dispute on that point, however. Ligado has long agreed that a 1 dB change is the appropriate standard for *co-channel* (in-band) emissions (*i.e., emissions into the GNSS band*). Ligado’s proposal clearly meets the standard in that band, the band that has been allocated to GNSS.

But neither the Commission nor the ITU has ever used a standard of a 1 dB C/N<sub>0</sub> degradation to protect a service from *transmissions in an adjacent band*, which is the situation

---

<sup>33</sup> See Garmin Comments at 9-12; Deere Comments at 3-6; Trimble Comments at 4-12 (citing no support for their argument that this standard be extended to afford protection to GPS in adjacent spectrum bands).

<sup>34</sup> Commenters such as Trimble implicitly acknowledge that the Commission need not resolve the 1 dB question, noting that the Commission should use the 1 dB standard “[t]o the extent it addresses the issues in assessing the amended Modification Applications. . . .” Trimble Comments at 12 (emphasis added).

<sup>35</sup> This issue has arisen because some GPS devices have been designed to receive signals not just from the GNSS band, but also signals outside the designated GNSS band—including in the Lower Downlink Band, which is near (but not even adjacent to) the GNSS band. Other commenters honed in on the significance of this difference. Stephen Wilkus explains that GPS receivers attempt to “establish prior-use rights in bands that are not allocated to their use.” He adds: “In other contexts . . . [this is] referred to as ‘squatting,’ and is considered akin to theft.” Wilkus Comments at 2.

the Modification Applications raise.<sup>36</sup> There is thus no basis for concluding that GPS is entitled to this type of protection in bands outside its allocated spectrum, such as the Lower Downlink Band that has been assigned to Ligado.

Not surprisingly, not a single commenter cites precedent for applying 1 dB C/N<sub>0</sub> as a criterion for harmful interference from transmissions in an adjacent band. Instead, commenters attempt to conflate the use of the 1 dB standard to regulate *co-channel* emissions and use of the standard to regulate transmissions in an *adjacent* band. Yet as explained in Appendix A, the history and context of the 1 dB metric reveal that, regardless of the metric's potential utility in other contexts, applying the standard to Ligado's proposed terrestrial operations in a band adjacent to the GPS band is unprecedented and unnecessary for purposes of the Modification Applications.

Second, commenters urge the Commission to adopt the 1 dB standard because it is important to have a standard that is reliable and consistent. These commenters critique the use of Key Performance Indicators ("KPIs")—which is odd given that this metric is rooted in the Commission's definition of "harmful interference"<sup>37</sup>—on the grounds that KPIs "simply cannot provide a reliable basis for determining whether harmful interference has occurred in particular use cases."<sup>38</sup> That argument must fail, since it overlooks the *inherent unreliability* of 1 dB.

---

<sup>36</sup> See Appendix A for additional information on the Commission's use of the 1 dB standard.

<sup>37</sup> The Commission's rules define "harmful interference" as "interference which endangers the functioning of a radionavigation service or other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations." 47 C.F.R § 2.1(c).

<sup>38</sup> See Trimble Comments at 11.

Ligado has previously outlined in detail the problems with the 1 dB metric—namely, that both theoretical analyses and empirical testing have demonstrated that the 1 dB metric is inaccurately and inconsistently measured; is arbitrary; and represents a flawed proxy for harmful interference because it does not translate to any predictable impact on *actual* device performance.<sup>39</sup> If the commenters are really in search of an “objective”<sup>40</sup> and “universal”<sup>41</sup> metric, 1 dB clearly will not suffice. The 1 dB C/N<sub>0</sub> metric is neither measured nor reported according to an established standard. Instead, each manufacturer uses its own proprietary C/N<sub>0</sub> estimation algorithms, and different devices (even those designed and manufactured by the same single manufacturer) use different algorithm measurement parameters. How can a regulatory agency adhering to the requirements of the Administrative Procedure Act regulate based on a metric that is not defined and not consistently measured or reported?

Notably, testing from the DOC-DOD jointly run National Advanced Spectrum and Communications Test Network (“NASCTN”) results shows that GNSS devices not only report different changes in C/N<sub>0</sub> when faced with the *identical* RF spectrum environment, but different devices *by the same manufacturer* report different changes in C/N<sub>0</sub>.<sup>42</sup> Equally problematic from the perspective of reasonable and rational decision making, NASCTN’s data show that for some

---

<sup>39</sup> See Letter from Gerard J. Waldron to Marlene H. Dortch, IB Docket No. 12-340 (Oct. 13, 2015) (responding to Garmin’s 1 dB proposal); Letter from Gerard J. Waldron to Marlene H. Dortch, IB Docket No. 12-340 (Oct. 26, 2013) (incorporating comments on DOT draft test plan contesting 1 dB proposal). See also Letter from Gerard J. Waldron to Marlene H. Dortch, IB Docket No. 11-109 (June 5, 2017), at 14, 21-27 (discussing use of 1 dB in DOT testing).

<sup>40</sup> Garmin Comments at 11.

<sup>41</sup> Garmin Comments at 11; Deere Comments at 4.

<sup>42</sup> See NASCTN Report at 271-75.

devices,  $C/N_0$  fluctuates by multiple dBs in a “natural state”—*i.e.*, even in the absence of *any* wireless signals in the proposed Ligado bands.<sup>43</sup>

Notwithstanding these critical considerations, which provide essential context to the 1 dB discussion, perhaps the most telling point about the commenters’ 1 dB position comes from Garmin, which appears to acknowledge that Ligado’s transmissions in the Lower Downlink Band adjacent to the GPS band meet the 1 dB standard as to its devices. Garmin’s comments state:

Garmin agreed not to oppose the Ligado Modification applications precisely because, speaking only for Garmin’s devices, the technical parameters to which it agreed in the Settlement Agreement were based on its own testing using the 1dB Standard.<sup>44</sup>

Furthermore, the NTIA and the Air Force long ago agreed that GPS receivers were not entitled to protection outside of their designated band. Specifically, as reflected in GPS BLKIII Satellite Payload Spectrum Certification JF 12/09603, OMB Circular A-11 of July 12, 1999, and OMB Circular A-11 of August 18, 2011:

The certification of the GPS-III satellite in May 2010 made it clear that NTIA and the Air Force had agreed that *GPS receivers were not entitled to protection for a bandwidth of greater than 24 MHz (extending from 1563-1587 MHz, outside the spectrum on which Lightsquared intends to operate).*

---

<sup>43</sup> Theoretical analysis of the relationship between  $C/N_0$  and device functionality is consistent with these empirical data showing that a decrease of 1 dB in  $C/N_0$  does not translate to impairment to GPS device performance. See Mark A. Sturza, *Changes in  $C/N_0$  Are Not a Reliable Indicator of KPI Impact* (June 6, 2016), available at [http://licensing.fcc.gov/myibfs/download.do?attachment\\_key=1138181](http://licensing.fcc.gov/myibfs/download.do?attachment_key=1138181).

<sup>44</sup> Garmin Comments at 10. Because all of the GPS companies that filed in this proceeding have entered into co-existence agreements with Ligado, it has long been obvious that only one of two conclusions can logically be drawn: either (1) Ligado meets the 1 dB standard (as Garmin acknowledges it does), even outside of the GNSS band—a standard for which there is no precedent, or (2) the 1 dB standard is not the relevant metric to apply in this case. Either way, considerations around the 1 dB standard should not prevent the Commission from moving forward to approve the Modification Applications as amended.

Thus, since May of 2010, the key government players involved with spectrum and GPS policy and operations have recognized and agreed that GPS receivers are not entitled to protection from operations in bands assigned to Ligado. Notwithstanding this recognition, Ligado has made extraordinary offers to be a good spectrum neighbor and address GPS industry concerns by relinquishing ten megahertz of spectrum to create a guard band and dramatically reducing its power in the Lower Downlink Band by more than 99.9% from the level authorized in 2010 and more than 99.3% from the maximum reflected in the Modification Applications.

All of these factors—the government’s acknowledgement, the statement from Garmin, the co-existence agreements with the five major GPS device manufacturers, the thousands of hours of testing at the DOC-DOD labs, the ubiquity of smartphones and tablets that have no problem co-existing with Ligado’s proposed operations, and the constant, continuing evolutions in the GPS ecosystem<sup>45</sup>—enable the Commission to find that GPS devices will receive the type of protection from Ligado’s proposed operations they need and to which they are entitled by law.

---

<sup>45</sup> For example, both Septentrio and MITRE are advertising GPS systems with antennas that can filter LTE signals to avoid interference and make receivers more resilient against many sources of possible interference, including adjacent band operations. See Septentrio, *Septentrio unveils the new Altus NR3 at InterGEO* (Sept. 9, 2017), <http://www.septentrio.com/company/news/septentrio-unveils-new-altus-nr3-intergeo> (announcing that Septentrio’s new antenna “features Septentrio’s pioneering AIM+ interference mitigation and monitoring system allowing continued operation in the presence of both intentional and non-intentional interference”). Similarly, according to UNAVCO, DOT’s adjacent band GNSS receiver tests “show that UNAVCO’s networks would not be impacted if/when [Ligado’s proposal] is approved and implemented.” Glen S. Mattioli, Geodetic Infrastructure Director and PBO Director, UNAVCO, *Polar Support Services for Continuous GNSS Installations: Status and Future of GNET*, GNET 2017 Workshop, (Jan. 25, 2017).

**IV. IRIDIUM’S COMPLAINTS ARE BASELESS AND SHOULD BE REJECTED SINCE DOD CIO CONCLUDED THAT LIGADO’S OPERATIONS WILL NOT CAUSE HARMFUL INTERFERENCE.**

Iridium repeats again its claim that Ligado’s proposed terrestrial operations will produce harmful interference to Iridium devices. But close analysis from the DOD and its outside consultant Alion Science and Technology Corporation (“Alion”) confirms that Iridium’s claims are wrong and that Iridium’s devices will not experience harmful interference from Ligado’s transmissions in the 1627.5-1637.5 MHz band.<sup>46</sup>

As part of its continuing efforts to resolve the concerns of various stakeholders, Ligado began engaging with Iridium regarding its concerns in the middle of 2016. Doug Smith, Ligado’s Chief Executive Officer, had phone calls with Matt Desch, Iridium’s Chief Executive Officer on September 21, 2016, September 28, 2016, October 11, 2016, and April 20, 2017 for that very purpose, but those discussions went nowhere. In May of 2017, the Office of the Department of Defense Chief Information Officer (“DOD CIO”) reached out to both Ligado and Iridium and informed the parties that it had consulted with the Commission and NTIA, and that DOD—the largest single customer of Iridium—was going to take the lead on attempting to understand and hopefully resolve the technical dispute. Ligado had multiple meetings and discussions with the DOD CIO, and on information and belief Iridium did as well, between mid-June 2017 and mid-August 2017. In connection with these efforts, the parties were informed that DOD CIO had engaged Alion to conduct a thorough analysis of the impact of Ligado’s proposed

---

<sup>46</sup> It also is notable that when Iridium recently sought and received approval to operate mobile earth station terminals operating as close as 8 MHz to the GNSS band, GPS interests commented on the terminals’ potential out-of-band emissions but never raised concerns about the impact of the terminals’ adjacent-band transmissions—despite the fact that the proposed terminals are intended to operate at higher power than Ligado’s proposed operations and in closer proximity to the GNSS band. *See* SES-MOD-20170413-00388.

ATC terminal transmissions in the 1627.5-1637.5 MHz band on Iridium’s Mobile Satellite Service (“MSS”) terminals receiving space-to-earth signals.

Alion presented the final results of its analysis, which was based on more than 30 simulations, to representatives from Ligado and DOD on August 28, 2017. On information and belief, Iridium received a similar briefing sometime in September-October 2017. The Alion simulations used industry standard assumptions of network and technology parameters for the analysis, with an Iridium receiver interference threshold of -6 dB I/N, which was used at Iridium’s suggestion. The analysis was done for the worst case, assuming the Iridium receiver was operating at 1626.5 MHz, only one megahertz away from Ligado’s uplink band at 1627.5-1637.5 MHz. The Alion analysis concluded that Ligado’s proposed ATC terminals would not cause harmful interference to Iridium’s MSS terminals.

Iridium is well aware of these results commissioned by its largest customer, but does not acknowledge them; all it does is recycle past complaints. Nevertheless, given that objective third party analysis demonstrates that Ligado’s proposed terrestrial operations will not create harmful interfere for Iridium’s MSS terminals, the Commission should not delay approval on the basis of Iridium’s claims.

**V. RECENT FILINGS BY SATCOM AND WEATHER PARTIES SIMPLY REHASH ARGUMENTS LIGADO HAS ALREADY ADDRESSED.**

Certain satellite communications (“SATCOM”) and weather-related parties recently filed an *ex parte* letter <sup>47</sup> citing (and at times conflating) an assortment of issues. The SATCOM and weather parties claim Ligado’s proposed operations will generate “interference [that] will be particularly impactful to the countless government and commercial entities that rely on GPS and

---

<sup>47</sup> See SATCOM and Weather Parties’ Letter.

SATCOM services for aviation safety and other critical services and the many groups that receive and depend upon real-time weather and related environmental information from National Oceanic and Atmospheric Administration (“NOAA”) satellites.”<sup>48</sup> Unpacking these issues reveals that Ligado has, in fact, resolved them all. As the table below illustrates, each of these questions has been asked and answered.

| <u>Issue</u>  | <u>Status</u>  |
|---|--|
| Government entities’ use of GPS                           | <p><b>Resolved.</b></p> <p>Ligado has committed to providing specific mitigation measures for U.S. government GPS devices, including the repair or replacement of such devices if necessary, both pre- and post-deployment.</p>  |
| Government entities’ use of SATCOM                        | <p><b>Resolved.</b></p> <p>DOD-sponsored analysis by Alion concluded that Ligado’s proposed terrestrial operations will not cause harmful interference to Iridium’s operations. See Section IV above.</p>  |
| Commercial entities’ use of GPS                           | <p><b>Resolved.</b></p> <p>Co-existence agreements with the five major GPS device manufacturers, thousands of hours of testing at NASCTN, and Ligado’s adopting of the power level set in the DOT Report confirm and ensure that Ligado’s proposed terrestrial operations will not cause harmful interference to commercial GPS devices.</p> |
| Commercial entities’ use of SATCOM                        | <p><b>Resolved.</b></p> <p>DOD-sponsored analysis by Alion concluded that Ligado’s proposed terrestrial operations will not cause harmful interference to Iridium’s operations. See Section IV above.</p> <p>Ligado and Inmarsat are developing a commercial and technical plan to address any potentially necessary retrofitting.</p>       |
| Weather entities’ use of information from NOAA satellites | <p><b>Resolved.</b></p> <p>Ligado has committed to the development of protection zones and a content delivery network to protect both NOAA and non-NOAA use of information collected from NOAA satellites. These issues are the subject of a separate proceeding with a robust record, RM-1168.</p>  |

---

<sup>48</sup> *Id.* at 1.

The SATCOM and weather parties' *ex parte* letter therefore raises no issues<sup>49</sup> that need to delay the Commission's approval of Ligado's modification applications.

**VI. THE COMMISSION SHOULD SEIZE THE OPPORTUNITY TO UNLOCK PRIME LOW FREQUENCY MID-BAND SPECTRUM FOR THE TRANSITION TO 5G.**

With the Modification Applications, the Commission has the opportunity to make thirty-five megahertz of low frequency mid-band spectrum available to drive forward the transition to 5G and hasten development of the Internet of Things. This opportunity is especially important in light of growing understanding about the realities of "mid-band" spectrum.

Participants in and regulators of the spectrum market have grown accustomed to the shorthand of referring to essentially all spectrum between 1 GHz and 6 GHz by the catch-all category of "mid-band." But critically, "not all mid-band spectrum is created equal."<sup>50</sup>

In fact, while the 1.5 GHz range provides an "ideal mix of coverage and capacity,"<sup>51</sup> other spectrum considered within the "mid-band" has presented serious challenges for operational deployment. Key problems with spectrum outside the 1-2 GHz range were underlined by John Saw, Sprint's Chief Technology Officer, in his explanation of the need for the Sprint-T-Mobile merger. As Mr. Saw explains, Sprint's reliance on its 2.5 GHz spectrum has

---

<sup>49</sup> The SATCOM and weather parties make reference to the National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum ("NPEF") "gap analysis" but fail to address Ligado's response to the gap analysis that Ligado has filed in the docket. *See* Letter from Gerard J. Waldron, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109; IBFS File Nos. SES-MOD-2015-1231-00981, SAT-MOD-20151231-00090, and SAT-MOD-20151231-00091 (April 12, 2018).

<sup>50</sup> *Fool's Gold? Not all Mid-Band Spectrum is Created Equal*, MoffettNathanson (July 2, 2018) ("MoffettNathanson Article").

<sup>51</sup> *L-Band: The 1500 MHz IMT Range*, GSMA (Dec. 2017) ("GSMA Report").

produced only 64% indoor penetration coverage among all 2.5 GHz POPs covered.

Furthermore, because of the propagation characteristics of 2.5 GHz spectrum (which also apply to newer bands like CBRS and C-Band), current Sprint subscribers often do not experience continuous coverage when moving around the Sprint network that operates on 2.5 GHz spectrum, which has significantly affected broader perceptions about the reliability of Sprint's network.<sup>52</sup>

These issues are reinforced by the findings of the British communications regulatory body, Ofcom. In a 2014 report, Ofcom measured signal loss at 88 MHz, 217 MHz, 2.4 GHz and 5.8 GHz, for a variety of scenarios including older homes and a modern, baseline house. Ofcom's results show that, as compared to 2.5 GHz spectrum, 3.5 GHz spectrum appear to show an incremental 3 dB loss in propagation.<sup>53</sup>

By contrast, the cost and efficacy advantages of deploying in the 1-2 GHz band are abundantly clear. Given its characteristics, the 1.5 GHz range in particular—part of the low-frequency mid band—“will form a vital part of mobile broadband networks in the near future.”<sup>54</sup> And while there are several new sources of spectrum within the broader 2-6 GHz range coming to market, such as CBRS or C-Band, there is not as much spectrum available in the 1-2 GHz range. The Commission has the opportunity to make available 35 megahertz in the 1.5 GHz / 1.6 GHz band with approval of the pending Modification Applications.

---

<sup>52</sup> See MoffettNathansen Article at 3-4.

<sup>53</sup> See Richard Rudd *et al.*, *Building Materials and Propagation: Final Report*, Ofcom, 2604/BMEM/R/3/2.0 (Sept. 2014), available at [https://www.ofcom.org.uk/\\_\\_data/assets/pdf\\_file/0016/84022/building\\_materials\\_and\\_propagation.pdf](https://www.ofcom.org.uk/__data/assets/pdf_file/0016/84022/building_materials_and_propagation.pdf). See also MoffettNathansen at 4.

<sup>54</sup> GSMA Report at 1.

\* \* \*

As detailed above, Ligado's proposed operations will protect certified aviation GPS devices, all other GPS devices, and will not create harmful interference to other services operating near Ligado's spectrum. The Commission now has a record to approve the Modification Applications as amended.

Respectfully submitted,

/s/ Gerard J. Waldron  
Gerard J. Waldron  
Brian Smith  
Ani Gevorkian  
COVINGTON & BURLING LLP  
One CityCenter  
850 Tenth Street, NW  
Washington, DC 20001  
(202) 662-6000

*Counsel for Ligado Networks LLC*

July 19, 2018

**Appendix A**  
**The Lack of Precedent for Using the 1 dB Standard for the Modification Applications**

As the Commission well knows, interference to services operating in their allocated spectrum can come from two possible sources: (1) co-channel emissions, and/or (2) transmissions in an adjacent band. Co-channel emissions refer to emissions within the *same* band of spectrum at issue (in-band), whereas transmissions in the adjacent band refer to transmissions that occur in a *band adjacent to* (or in the general vicinity of) the band at issue. Separate Commission rules regulate each source.

Co-channel interference rules protect services such as GNSS from interference caused by emissions in the same band, and potential co-channel interference primarily comes from one of two sources. The first relates to interference from services licensed to operate within a given band. The Commission's rules over this first type of interference are intended to promote co-existence between services in the same band by limiting the amount of energy a service can emit that would raise the noise floor of a different service in the same band. The rules therefore require services operating in the same band to limit their emissions so as to not cause a 1 dB rise in the noise floor of the co-channel service.

<sup>1</sup> For GNSS, this means that spectrum regulators require any service, other than GPS, operating *in the same band* as GPS (1559-1610 MHz) not to cause more than a 1 dB rise in the noise floor. These rules are *not applicable* to the Modification Applications because Ligado of course does not operate in the GPS band.

---

<sup>1</sup> See e.g., *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550–3650 Mhz Band, Order on Reconsideration and Second Report and Order*, FCC 16-55, 31 FCC Rcd. 5011 ¶ 265 (2016) (establishing rules to protect in-band FSS earth stations from in-band interference).

The second potential source of co-channel interference relates to interference from out-of-band emissions into the band of the service to be protected. For example, with respect to GNSS, the Commission has set limits on the amount of out-of-band emissions services in adjacent bands may generate into the GNSS band (1559-1610 MHz). The Commission first adopted this requirement in 1998,<sup>2</sup> and both GPS manufacturers and services in adjacent bands have been aware of this obligation since then. These rules, too, are *not applicable* to Modification Applications because the issue at hand relates to GPS performance in the Lower Downlink Band, *not* in the GNSS band. In any event, however, Ligado’s base station emission value of -100 dBW/MHz and user terminal emission value of -105 dBW/MHz into the GNSS band are significantly lower than emissions from any other bands into GNSS.

By contrast, rules related to *transmissions in an adjacent band* seek to protect a service, such as GNSS, from interference caused not by services operating within the same band, but by a different service operating in an adjacent band—or in a band sufficiently near the band of interest even if it is not truly “adjacent.”<sup>3</sup> For this situation, the Commission and other spectrum regulators have mandated maximum transmitted power levels and specific “emissions masks” (*i.e.*, the level of signal allowed at various spectral distances from the transmitting signal band). When this type of protection is afforded to a service, it is meant to ensure that operations in an adjacent band will not cause harm to the service or devices in another band, and it indicates that the services or those devices are entitled to a proscribed level of protection outside their own band. This is the situation relevant to the Modification Applications.

---

<sup>2</sup> 1998 Biennial Regulatory Review, Report and Order, FCC 98-338, 13 FCC Rcd. 24687 (released Dec. 23, 1998).

<sup>3</sup> “Adjacent” bands are usually immediately next to the subject band and not 23 megahertz away.

However, in every instance where the Commission (and the ITU) had an opportunity to apply 1 dB  $C/N_0$  as a criterion for harmful interference to define transmissions in an adjacent band, it has refrained from doing so. In other words, neither the Commission nor the ITU has ever held that the 1 dB standard should apply to a situation such as Ligado's. Nevertheless, again consistent with its position of being a good spectrum neighbor and proactively finding solutions for interested stakeholders, Ligado has proposed in the Amendment a cumulative power reduction in the Lower Downlink Band of more than 99.9% from the level authorized in 2010 and more than 99.3% from the maximum reflected in the Modification Applications.